**Resilience Design Patterns - A Structured Approach to Resilience at Extreme Scale**  
*(Specification Version 1.2)*

**Achievement:** Released version 1.2 of resilience design patterns specification. New specification contains additional patterns, modified hierarchical classification to highlight the relationships between existing and new patterns. Improved existing pattern solution descriptions to comply with standards adopted by design patterns community.

**Significance and Impact:** The resilience design patterns specification provides HPC system architects and application developers with a collection of reusable design elements, and a discipline to combine an essential set of design patterns into productive and efficient resilience solutions. With the new specification, a more comprehensive set of design patterns are available to enable a systematic improvement of resilience in HPC systems, keeping scientific applications running to a correct solution in a timely and efficient manner in spite of frequent faults, errors, and failures.

**Research Details:**
- Identified and evaluated new patterns for failure detection to complement existing set of resilience patterns. Pattern descriptions include details of the problems and solutions in HPC environments.
- Improved the catalog of design patterns
- Modified the hierarchical classification of the design patterns to highlight relationships between new and existing patterns

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**Publications:**

**Overview:**
The version 1.2 of the resilience design pattern specification contains improved descriptions of numerous techniques used in the design of resilience solutions for HPC systems and their applications. A design pattern describes a generalizable solution to a recurring problem that occurs within a well-defined context.
Patterns are often derived from best practices used by designers and they contain essential elements of the problems and their solutions. They provide designers with a template on how to solve a resilience problem that may be used in many different situations. The patterns in the catalog provide solutions for detection, containment and recovery for faults, errors and failures. This work also defined a conceptual framework based on the notion of design spaces that guides hardware and software designers and architects, as well as application developers, in navigating the complexities of developing effective resilience solutions. The framework enables designers to combine the patterns and refine their interactions to create alternative resilience solutions for a specific problem, each with different efficiency and complexity characteristics.